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THE ANNUAL WATER BALANCE OF THE ARCTIC OCEAN

by

V. T. Timofeev

The Arctic Ocean is subdivided into two ocean basins: the North European and the Arctic. They are divided by a line running along the Nansen Sill between North East Cape (Greenland) and Amsterdam Island (Spitsbergen) through White and Victoria Islands toward Cape Mary Harmsworth (Franz Josef Land), then from Cape Kol'zet (Mys Kol'zet) toward Mys Zhelaniya and further along the eastern edge of the Novaya Zemlya straits.

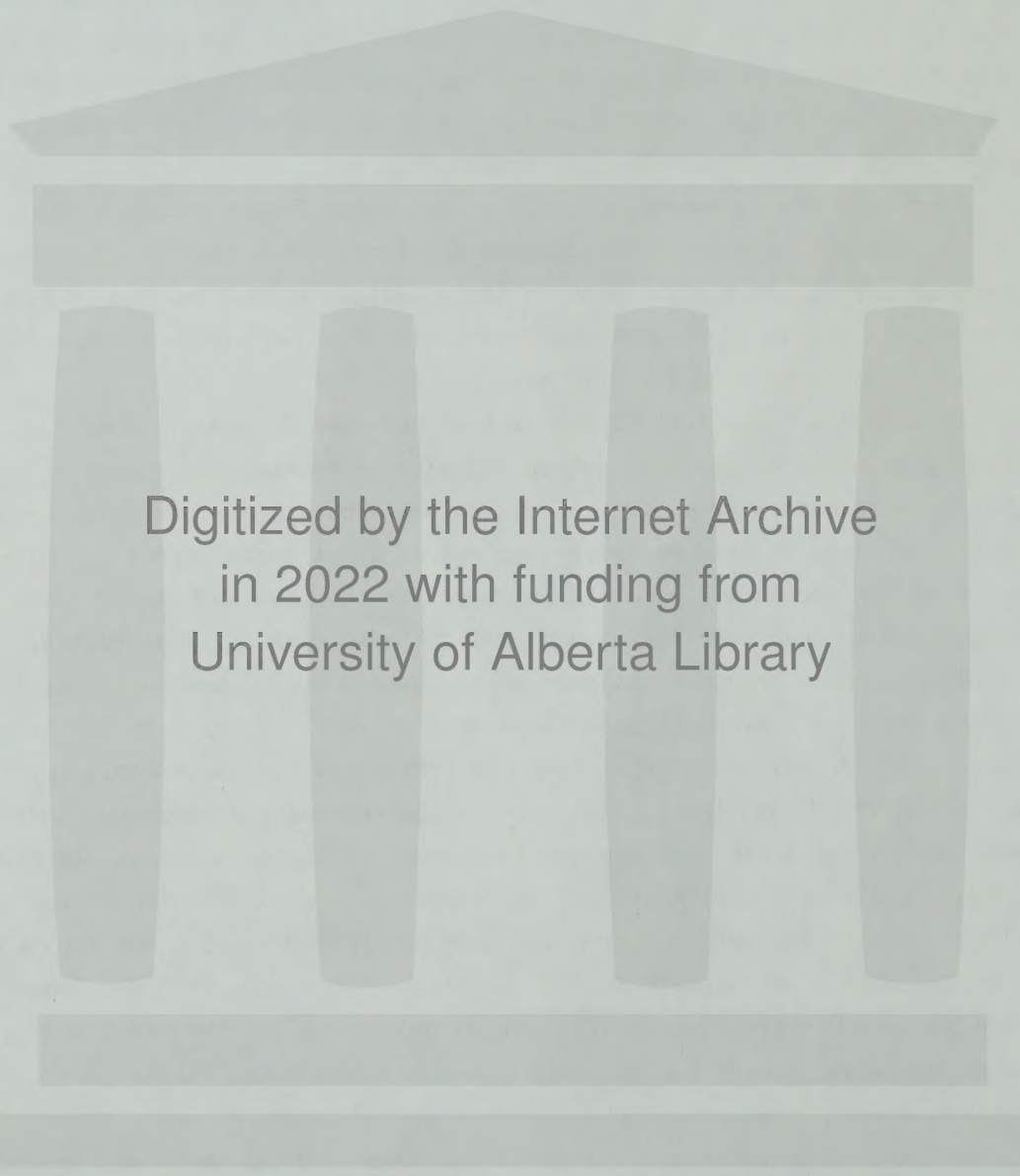
In recent years, Soviet scientists discovered a vast ridge, running from the New Siberian Islands toward Ellesmere Island, which has been called the Lomonosov Range, after a decision of the Presidium of the Academy of Sciences in 1954. This ridge divides the Arctic Basin into two parts, which have essentially different hydrological regimes.

As a whole, the waters of the Arctic Ocean are formed, to a certain extent, by Atlantic and Pacific waters and also by continental runoff. These sources bring waters of different physical-chemical properties into the Arctic Ocean. In order to draw reliable conclusions about their effect on the water regime of the Arctic Ocean, it is important to know how much water these sources bring in, how much water is removed from the Arctic and by what routes.

To determine the water balance of the Arctic Ocean, one must take into account the main sources of gain and causes of loss. Water from the Atlantic and Pacific Oceans, river water from the continents and atmospheric precipitation bring water into the Arctic Ocean, while the water loss is due to the removal of ice and water from the Arctic Ocean, chiefly by the East Greenland Current, and also by evaporation. In an approximate calculation of the water balance, precipitation and evaporation may be assumed equal. One is justified in making such an assumption on the grounds that, compared with the other factors, these factors have little specific weight in determining the water balance. Furthermore, at present the precipitation and evaporation values have not been determined even approximately.

It has been established that the main water exchange between the Arctic and Atlantic Oceans passes along the cross section Sogne Fjord - Iceland through the Faroe-Shetland Strait, and also the Denmark Strait.

There are two steady currents in the Faroe-Shetland Strait that run in opposite directions: in the eastern part of the strait, the current runs north, in the western part, it runs south. According to calculations made at the



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Arctic Institute, the mean long-range influx of water from the Atlantic Ocean through the eastern part of the strait amounts to about $400,000 \text{ km}^3$ per year. About $248,000 \text{ km}^3$ per year enter the Atlantic from the Arctic Ocean through the western part of the strait; thus, the resultant annual gain of water through the Faroe-Shetland Strait is about $152,000 \text{ km}^3$.

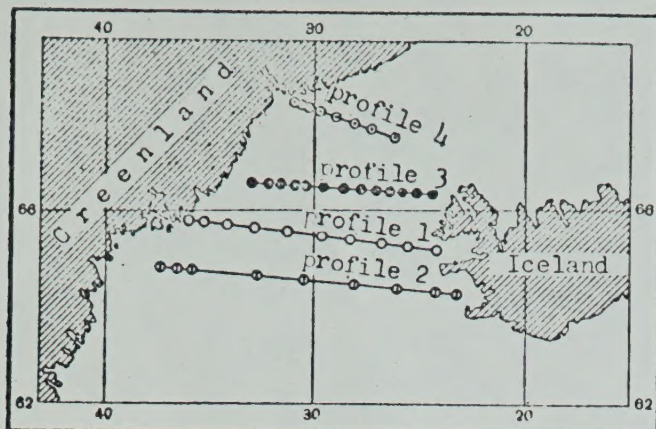
Little study has been devoted to the hydrological regime of the Denmark Strait. From fragmentary information, one can gather that the regime is very complex. Oppositely directed currents are found in this strait: the cold East Greenland Current coming from the north, and the warm Irminger Current from the south (in the eastern half). Calculations have indicated that about $36,000 \text{ km}^3$ of Pacific water enter the Arctic Ocean annually through Bering Strait.

Calculations made at the Arctic Institute show that the total annual runoff of rivers bearing continental waters into the Arctic Basin is about 4400 km^3 . Of course, such an amount of water is insignificant when the total water balance is taken into consideration. Although small in volume, these continental waters have a considerable influence on the hydrological and ice regimes of the arctic seas. About $192,400 \text{ km}^3$ of water enter the Arctic Ocean through the Faroe-Shetland and Bering Straits and due to continental runoff. Assuming that a like amount of water leaves the Arctic Ocean through the Denmark Strait and the numerous straits of the Canadian Arctic Archipelago, one may assume the following approximate water balance for the Arctic Ocean.

Table 1
Annual water balance of the Arctic Ocean

Place	Total influx (km^3)	Total runoff (km^3)	Total gain (km^3)	Total loss (km^3)
Faroe-Shetland Strait	400,000	248,000	152,000	-
Bering Strait	36,000	-	36,000	-
Continental runoff	4,400	-	4,400	-
Denmark Strait and the straits of the Canadian Arctic Archipelago	-	192,400	-	192,400
Total balance	440,400	440,400	192,400	192,400

By using four profiles (see figure) in the Denmark Strait, one may get some approximate idea of the water exchange through this strait, and, consequently through the straits of the Canadian Arctic Archipelago. Table 2



Location of hydrological profiles in the Denmark Strait.

through this strait from the Greenland Sea. As a result, the annual removal of water from the Arctic Ocean through the Denmark Strait is about $161,000 \text{ km}^3$.

gives data on the discharge of water through the Denmark Strait

These values differ greatly for individual years (August 1929 and 1933) as well as during the year (March and August 1933). On an average, the annual discharge of water through the Denmark Strait from the Atlantic Ocean is about $89,000 \text{ km}^3$, while the East Greenland Current removes about $250,000 \text{ km}^3$ of water annually

Table 2
Discharge of water through the Denmark Strait

Profile number	Date of cross section	Water discharge in km^3/hr		
		to the N	to the S	net southward flow
1	13-17 August 1929	6.54	18.22	11.68
2	25-28 March 1933	24.28	82.20	57.92
3	30-31 July 1933	8.47	10.57	2.10
4	21-22 August 1933	1.37	3.01	1.64

Comparing these figures on the gain and loss of water, we find that more water enters the Arctic Ocean ($192,400 - 161,000 = 31,400 \text{ km}^3$) than leaves it through the straits examined. Evidently, these $31,400 \text{ km}^3$ are carried off annually through the straits of the Canadian Arctic Archipelago.

Of course, these computations are not very accurate at present. Just the same, the data obtained give a general quantitative idea of the main factors that comprise the hydrological regime of the Arctic Ocean and also they show the role of the Atlantic and Pacific currents in the water balance of the Arctic Ocean.

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